(No Model.)

2 Sheets—Sheet 1.

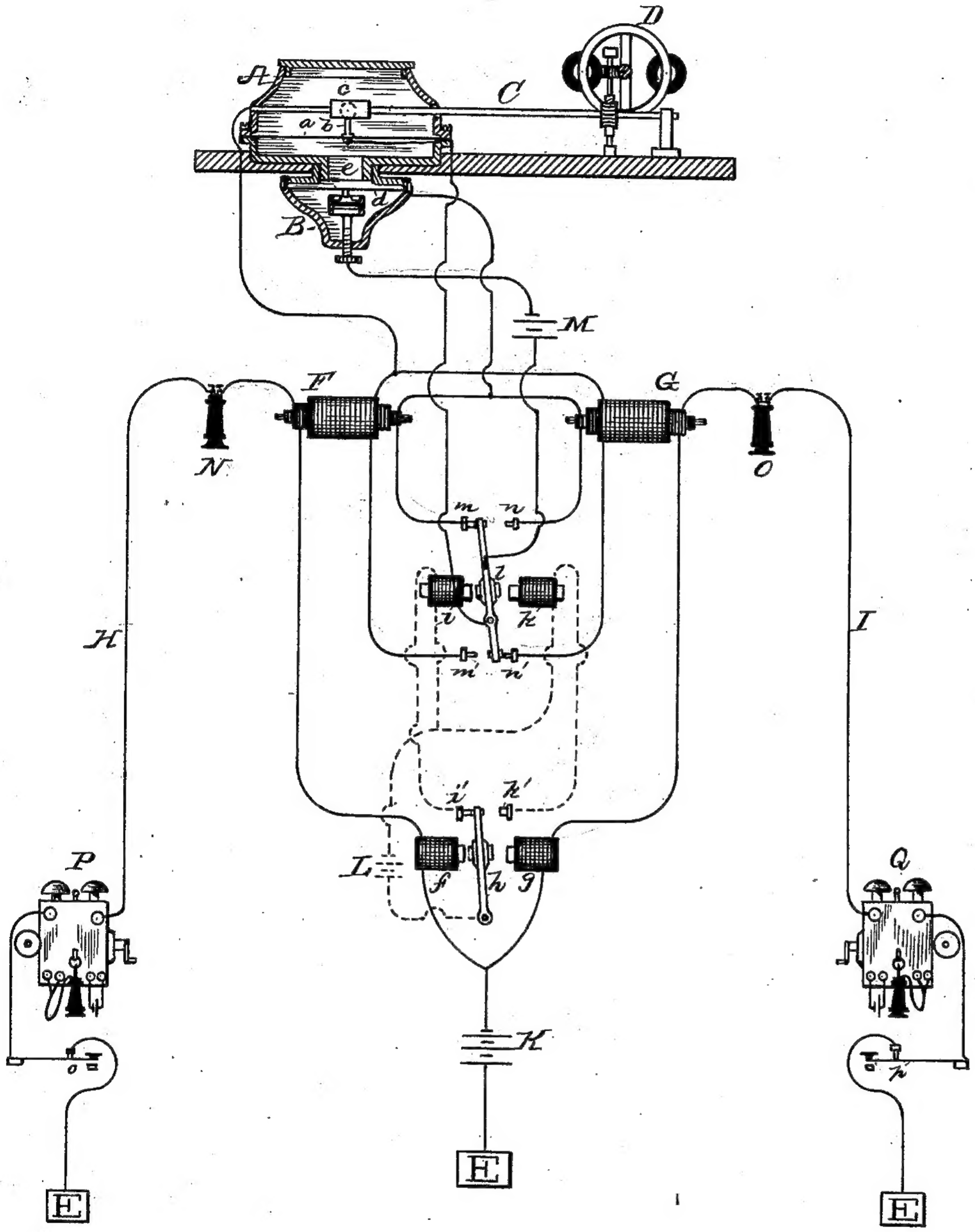
T. A. EDISON.

TELEPHONE REPEATER.

No. 422,579.

Patented Mar. 4, 1890.

Fig 1.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

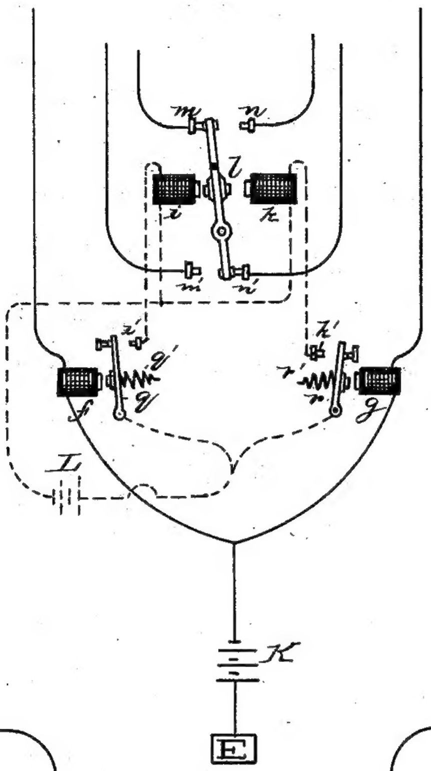
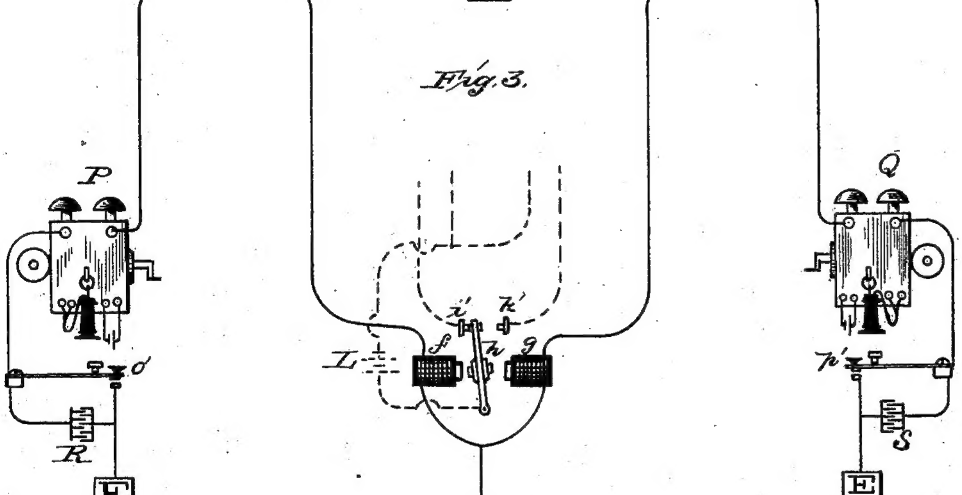


Fig. 3.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEPHONE-REPEATER.

SPECIFICATION forming part of Letters Patent No. 422,579, dated March 4, 1890.

Application filed December 15, 1884. Serial No. 150,346. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telephone-Repeaters, (Case No. 638,) of which the following is a specification.

The object I have in view is to produce a telephone-repeater for relaying telephone undulations from either of two lines to the other, which will be effective in operation, in that it will increase the volume of sound, and by its use will enable talking to be carried on over lines of any length, no matter how great, and will at the same time produce loud and clear articulation, preventing all confusion which might (but for the peculiar devices employed) be produced by the reciprocal action of the repeating-instruments.

The more specific objects I have in view are to improve the construction of the combined receiver and transmitter used as a repeating-instrument over those heretofore proposed, so as to better the articulation and increase the volume of sound; to produce an arrangement whereby one of such combined instruments can be used for repeating in either direction; to locate the battery for operating the relay-switch at the relay-office, thus doing away with the necessity of other than the usual telephone-batteries at the subscribers' telephones; to provide means whereby a centrally-located switching-battery can be used with lines of different lengths and resistances, and, further, to arrange for the observance of the operation of the repeating apparatus at the relay-office, so as to maintain it in working order.

The invention will be understood by reference to the accompanying drawings, in which—

Figure 1 is a view, partly in diagram, of a telephone-repeater embodying the principal features of my invention; Fig. 2, a similar view of the switching arrangement adapted for use with lines of different lengths and resistances; and Fig. 3, a similar view of a modified form of the switching arrangement, the circuit being normally opened instead of closed, as in Fig. 2.

For my repeating-instrument I use a combined receiver and transmitter A B. (Shown at the top of Fig. 1.) The receiver A is one of my electro-motograph or chalk telephone-receivers. Its diaphragm *a* has a central finger *b*, pressed by a suitable tension-adjusting device against a revolving chalk cylinder *c*, as will be well understood. The chalk cylinder is mounted on a shaft C, which is revolved constantly in any suitable manner, an electric motor D and worm-gearing being shown for that purpose. The transmitter B is preferably an ordinary form of my carbon transmitter, although other constructions of telephone-transmitters may be used. It has a diaphragm *d*, separate from the receiver-diaphragm. The cases of the receiver and transmitter are connected by a channel *e*, with closed walls, the result being a closed air space or chamber between the diaphragms of the two instruments. This construction is much more effective than one employing a single diaphragm common both to the receiving and transmitting devices, permitting, as it does, a separate and independent adjustment of such devices, while the body of air confined in the space between the diaphragms transmits the full effect from one diaphragm to the other.

The repeater has, in addition to the combined instrument just described, two induction-coils F G, each of which has three circuits—a primary, a secondary, and a tertiary. The three circuits become necessary, as will be presently shown, from the fact that the repeating-receiver is not acted upon directly by the line-currents, but by induction therefrom, which is a point of considerable moment in my apparatus.

The telephone-lines H I, which are shown connected through the repeater, extend to the secondaries of the induction-coils, and from thence through relay switching-magnets *f g*, after which they are joined to the same pole of a battery K, which has its other pole connected to earth E. These magnets are of high resistance and may be used to operate the switch directly; but I prefer to use them as a relay, closing by a centrally-located armature-lever *h* the circuit of a local battery L through either of two switching-magnets *i k* at points *i′ k′*. The armature *h* may be polarized and the parts be arranged to act as a polarized relay; but as shown the magnets *f g* oppose each other and act by simple magnetic attraction upon the said armature. The magnets *i k* act upon a central armature-lever *l* which is divided transversely by insulation and closes and opens circuits at four contacts *m n* and *m' n'*. The points *m n* on opposite sides of the upper end of lever *l* are connected to the primaries of the two coils F G, the other ends of such primaries being connected together and to one binding-post of the transmitter B. The other binding-post of the transmitter is connected through a battery M with the upper end of lever *l*, which end of the lever closes the transmitter and battery circuit through the primary of F or that of G, according to whether *l* is in contact with *m* or *n*. The contacts *m' n'* on opposite sides of the lower end of *l* are connected to the tertiary circuits of F and G, which at their other ends are connected together and to one post of the receiver A, the other post of such receiver being connected to the lower end of such lever. The lever *l* connects the receiver with the tertiary of one or the other induction-coil, according to the position of such lever, the tertiary of one coil being connected with the repeating-receiver, while the primary of the other coil is connected with the repeating-transmitter.

Between the repeater and the lines H I are located telephone-receivers N O of any suitable character, by means of which the operation of the repeater can be observed at the relay-station. Grounded telephone sets P Q are shown at the ends of the lines, and in addition to these keys *o p*, which keep the lines normally closed at their back points. Lines H and I being connected through the repeater, the current of battery K will be thrown upon the two lines. The magnets *f g* neutralizing each other in their effect upon armature *h*, the armature-lever will remain indifferently against either contact *i'* or *k'*.

If subscriber Q commences the conversation, he depresses key *p*, opening circuit of line I, demagnetizing *g*, and causing *h* to be drawn by *f* against *i'*. This is the position shown in Fig. 1 of the drawings. This closes circuit of local battery L through magnet *i*, throwing lever *l* into the position shown, connecting the receiver A with tertiary of G and the transmitter B and battery M with primary of F. Now subscriber Q releases key *p*, closing line I, and commences to talk, the closing of the line not affecting the switch. Before subscriber P replies he depresses key *o*, opening line H and shifting the switch to the other side, the effect being to connect the receiver with tertiary of F and the transmitter and its battery with primary of G.

When the parts are in the position shown in Fig. 1, the opperation of talking from Q to P takes place in the following manner: The current undulations on line I, corresponding with the sound-waves passing through secondary of G, act upon receiver, which is connected with tertiary of G. There in no action on primary of G, the circuit of which is open. Receiver A operates transmitter B, which, with its battery, being in circuit with primary of F, the sound-waves are repeated and thrown into current undulations upon line H, which current undulations are translated into sound-waves at P. There is no effect upon tertitary of F, since such tertiary circuit is open. In the manner described the current undulations can be repeated from one line to the other without confusion from the reciprocal action of the induction-coils, which would occur if the circuits were all kept closed. A single combined repeating-instrument is also made to repeat in either direction.

The centrally-located switching-battery is made possible by my arrangement. As shown in Fig. 1, the proper action of the magnets *f* and *g* on armature *h* is dependent upon the fact that the lines H and I are of the same or nearly the same resistance. If they were of widely-different resistances, the balance would be destroyed and the switch would remain always on one side. The switching arrangements I prefer to use overcome this difficulty.

Fig. 2 is an illustration of a closed circuit arrangement, and Fig. 3 shows an arrangement wherein the circuit is normally open.

In Fig. 2 the magnets *f g* have separate armatures *q r*, with retracting-springs *q' r'*. The magnets are wound and the retracting-springs are adjusted for the length of the lines, so that normally both levers are on their front contacts, breaking both branches of the local circuit of L. The opening of the circuit of either line by its key releases *q* or *r*, and lever *l* is thrown one way or the other and remains in one position until the other armature *q* or *r* is released.

In Fig. 3 the central armature *h* is used; but the circuit is open normally at keys *o' p'*, which are shunted by condensers R and S. The talking is carried on through the condensers, and the switch is operated by closing circuit at *o'* or *p'*.

The arrangement of Fig. 2 is preferred; but both the preferred and the modified arrangements are hereinafter referred to, except when the preferred arrangement is specifically described, when that alone is referred to.

What I claim is—

1. In a telephone-repeater, the combination of a telephone-receiver connected inductively with a line-circuit with a telephone-transmitter located or connected with relation to said receiver so as to be operated mechanically thereby, substantially as set forth.

2. In a telephone-repeater, an electro-motograph receiver used as a repeating-instrument, a telephone-line, and an induction-coil through which the repeating-receiver is connected with said line, in combination with telephone-transmitting devices operated thereby, substantially as set forth.

3. A telephone repeating-instrument hav-

ing in combination a telephone-receiver and a telephone-transmitter provided with separate diaphragms and independently-adjustable receiving and transmitting devices, substantially as set forth.

4. A telephone repeating-instrument having in combination a telephone-receiver and a telephone-transmitter provided with separate diaphragms connected by a closed chamber or channel, substantially as set forth.

5. In a telephone-repeater, the combination, with two telephone-lines, of a telephone-receiver and a telephone-transmitter operated by said receiver, connections between such receiver and transmitter and both of said lines, and a switch for completing and reversing such connections for relaying from either of said lines to the other, substantially as set forth.

6. The combination, with two interdependent telephonic circuits, of a single telephonic repeating-instrument and an electro-magnetic circuit-reverser adapted to be operated by the circuits alternately and operating to shift the electrical connections of the repeater with the circuits, whereby it is alternately brought into operative relations for receiving and repeating with the two circuits, substantially as set forth.

7. In a telephone-repeater, the combination, with two telephone-lines provided with induction-coils, of a single combined receiver and transmitter, a receiver-circuit, a transmitter-circuit with battery, and a switch operating to connect the receiver and transmitter with opposite induction-coils, substantially as set forth.

8. In a telephone-repeater, the combination, with two induction-coils, each having three circuits—a primary, a secondary, and a tertiary—of two telephone-lines, each connected with a circuit of one induction-coil, and a combined repeating receiver and transmitter connected with the two other circuits of such induction-coils, substantially as set forth.

9. In a telephone-repeater, the combination, with two induction-coils, each having three circuits, of two telephone-lines, each connected with a circuit of one induction-coil, and a repeating motograph-receiver and a repeating-transmitter connected with the two other circuits of such induction-coils, substantially as set forth.

10. In a telephone-repeater, the combination, with two induction-coils, each having three circuits, of two telephone-lines, each connected with a circuit of one induction-coil, a combined repeating receiver and transmitter connected with the two other circuits of such induction-coils, and a switch connecting the repeating receiver and transmitter circuits with opposite induction-coils, substantially as set forth.

11. In a telephone-repeater, the combination, with the repeating-instruments, of a switch in the line and a switch in a local circuit controlled by the line-switch and serving to switch the repeating-instruments, substantially as set forth.

12. In a telephone-repeater, the combination, with a switch controlling the repeating-instruments, of a centrally-located battery operating such switch for either of the two telephone-lines, substantially as set forth.

13. In a telephone-repeater, the combination, with a switch controlling the repeating-instruments, of a centrally-located battery, two telephone-lines connected with such switch and battery, and keys at the ends of the telephone-lines for operating the switch by such centrally-located battery, substantially as set forth.

14. In a telephone-repeater, the combination, with two telephone-lines, of a switching-magnet in each line, separate armature-levers for such magnets, the repeating-instruments, and connections controlled by the levers of the switching-magnets for shifting the connections of such instruments, substantially as set forth.

15. In a telephone-repeater, the combination, with the repeating-instruments, of a centrally-located switching-battery, a switch operated by such battery, normally-closed lines through such battery and switch, and keys for opening the lines to operate such switch, substantially as set forth.

16. In a telephone-repeater, the combination, with repeating-instruments, of a centrally-located switching-battery, a two-part switch operated by such battery from either line independent of differences in resistance of such lines, and normally-closed keys for operating such switch, substantially as set forth.

This specification signed and witnessed this 9th day of December, 1884.

THOMAS A. EDISON.

Witnesses:
WM. H. MEADOWCROFT,
THOS. G. GREENE, Jr.